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Interactive comment on "Ocean modelling for aquaculture and fisheries in Irish waters" *by* T. Dabrowski et al.

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Anonymous Referee #1 Received and published: 15 July 2015

General comments This work, as the title clearly states, delineates a working program that has ocean modelling at its core, and provides relevant and valuable support to the aquaculture and fish activities in Irish waters. This paper addresses relevant scientific issues within the general scope of OS, and meets the specific aims of the Special Issue thematic, under with it was submitted. However, the authors miss the opportunity to state this and, as such, should include a reference to the relevance of their work in this Special Issue. The work presented here merges several tools that together make an unparalleled product for the management and study Irish waters. In this context, it presents an original tool and concept. The authors adequately present this

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outcome has a conclusion to their work. The abstract has too much information. It can be reduced. Details on the model can be left out and authors should focus on the processes addressed and products that can be achieved with the model.

Authors' response: The abstract was reduced and details of the models were removed.

Authors' changes in manuscript: It now reads: "The Marine Institute, Ireland, runs a suite of operational regional and coastal ocean models. Recent developments include several tailored products that focus on the key needs of the Irish aquaculture sector. In this article, an overview of the products and services derived from the models are presented. The authors give an overview of a shellfish model developed in-house and that was designed to predict the growth, the physiological interactions with the ecosystem and the level of coliform contamination of the blue mussel. As such, this model is applicable in the studies on the carrying capacity of embayments, assessment of the impacts of pollution on aquaculture grounds and the determination of the shellfish waters classes.. Further services include the assimilation of the model-predicted shelf water movement into a new harmful algal bloom alert system used to inform end-users of potential toxic shellfish events and high biomass blooms that include fish killing species. Models are also used to identify potential sites for offshore aquaculture, to inform studies of potential cross-contamination in farms from the dispersal of planktonic sea lice larvae and other pathogens that can infect finfish and to provide modelled products that underpin the assessment and advisory services on the sustainable exploitation of the marine fisheries resources. This paper demonstrates that ocean models can provide an invaluable contribution to the sustainable blue growth of aquaculture and fisheries. "

The introduction clearly frames the work. However, because the paper is rather descriptive of current 'products', the reader can wonder about the reasons for this work to be published. Authors should address this in the introduction, stating that this paper is part of a Special Issue (and briefly state the aims of the SI). I believe this will give the full credit and relevance to this paper.

Authors' changes in manuscript: We have added the following paragraph as last in the Introduction section: "It should be noted that this paper is part of the Special Issue on operational oceanography in support of blue and green growth. Since the sustainable growth across various marine sectors requires timely delivery of high quality oceanographic products and services, the aim of this Special Issue is to inform the reader about the existing and ongoing developments in this regard. Within this context, the authors present the research results and the products and services that are at the different stages of advancements; some have already been published or being published, as indicated throughout the paper, whereas other are still preliminary."

Generally the paper is well structured and clear. Since I am not a native English speaker (unlike the authors), I refrain from making too much specific comments and grammatical corrections. However, I believe that the authors can and should revise the manuscript and improve its readability. Some statements are quite confusing and difficult to read. The message could benefit from some simplification.

Specific comments P1188, L19: This should be the inaugural statement of the abstract ('This paper demonstrates. . .')

Authors' response: The authors included this sentence at the end of the Abstract as a form of conclusion from the presented works, and as such, we believe it forms a good closing statement.

P1189, L10-13: ('These models. . .') Please re-arrange this sentence. It's not easy to read. Also, authors should add more references to works on the use of mathematical model in aquaculture.

Authors' response: This part of text has been revised. It also includes new modelling references.

Authors' changes in manuscript: The following text has been added to this paragraph: "Today, the above measures can be effectively supported by mathematical models,

which can vary in complexity The examples include highly aggregated, low data requirements tools (e.g. ASSETS, Bricker et al., 2003), tools addressing the production and ecological sustainability at a finer spatial scale (e.g. Ferreira et al., 2007) and more detailed and complex research models. The latter comprise of box models for analysis of mussel carrying capacity (Filgueira and Grant, 2009), ecosystem models to determine food depletion (Grant et al., 2008), and 2D or 3D biogeochemical models coupled with shellfish models (e.g. Brigolin et al., 2009; Cugier et al., 2010; Dabrowski et al., 2013 and the references therein; Grangeré et al., 2009, 2010; Guyondet et al., 2010; Maar et al., 2009; Nunes et al., 2011; Ren et al., 2010;) Numerical models used in aquaculture and fisheries studies can themselves vary in complexity, from general ocean circulation models to sophisticated coupled physical – biogeochemical – shellfish eco-physiological models, such as that presented in Dabrowski et al. (2013)." The reference list was updated accordingly.

P1189, L21-23: Developments tailor the model. 'Developments. . . have been tailored.' sounds confusing. Is there another way to present this information? The paragraph should not start with 'The Marine Institute...'

Authors' changes in manuscript: The opening sentences for this paragraph now read: "The authors developed and maintain a suite of operational forecasting regional and coastal ocean models of Irish waters. Several downstream services, driven by the end-user requirements, have been developed in recent years to address some key needs of the aquaculture and fisheries industries in the region."

P1191, L16: How is the carrying capacity actually calculated?

Authors' response: Since the authors did not actually study the carrying capacity and only point the reader to the model capabilities ("Furthermore, the model can assist with issues of production and ecological carrying capacities by running the experiments with alterations to standing stocks and with relocation and addition of new farms.") then it was removed from the title of this section. The title has also been changed to

3.1 Shellfish ecophysiological model. The closing paragraph of this section has been expanded to include more detail on how the model can be used in the carrying capacity studies (see authors response to P1192, L20-22 query below).

P1191, L17: 'which is based' - Please be more specific by naming the major similarities/ differences (state variables, processes, etc.)

Authors' changes in manuscript: More details have been added here: "The model governing equations remain the same, however, the rates of the following processes have been altered by the authors to achieve better model skill for Irish waters (see Dabrowski et al. (2014)): zooplankton grazing, nitrification rate, coagulation rate of small detritus and phytoplankton, small detritus remineralization rate and vertical sinking velocities of small detritus, large detritus and phytoplankton." The reference list was updated accordingly.

P1192, L20-22: This is poorly explained. How the model does this? More details are needed.

Authors' response: The use of word 'Furthermore' was inappropriate, as the second sentence was only an expansion of the first one pointing that the presented questions are widely known as the carrying capacity studies. The authors expanded this paragraph and believe the message should now be clearer.

Authors' changes in manuscript: The paragraph now reads: "The presented model can thus answer two overarching questions: what is the spatial distribution of growth potential in the bay and what impacts on the ecosystem are exerted by the farms (e.g. depletion of phytoplankton, dissolved inorganic nitrogen enrichment). The above studies are therefore useful for the estimation of production and ecological carrying capacities enabling to make informed management decision by the authorities responsible for the aquaculture sector. The production and ecological carrying capacities are interlinked and concern the studies on maximum production that the environment can sustain. Since the presented model is implemented in 3D and includes ecological interactions,

the carrying capacity issues can be addressed, for example, by running the experiments with alterations to standing stocks, relocation or removal of the existing farms, addition of new farms or change to farming practices (e.g. time of harvesting, rope vs. bottom cultures)."

P1193, L1: 'dependent on light, temperature and salinity' - using which algorithm?

Authors' changes in manuscript: The sentence has been amended: "...dependent on light, temperature and salinity following Canteras (1995) and recently successfully used by Mateus et al. (2013)..." and the reference list was updated.

P1194, L11-12: 'that is they do not have any behaviour attached to them..' consider removing this sentence.

Authors' changes in manuscript: The sentence has been removed and the previous sentence now reads: "The passive particles are released at the above transects over the first 12 hours and at 30 minute intervals upon the execution of each simulated three-day forecast."

P1194, L25- : This paragraph is too big, making the reading rather difficult

Authors' changes in manuscript: The paragraph now reads: "Ireland's southwest coast frequently experiences shellfish farm closures due to HABs. Contaminated shellfish can take many months, especially in winter, to depurate the HAB biotoxins. Depuration times can be highly variable and are likely related to food availability among other things such as the metabolic rate of the bivalves (Marcaillou et al. 2010, Jauffrais et al. 2012). A HAB warning system will give farmers the opportunity to extract product before long closures occur. In 2013, one or more farms were closed when biotoxins in shellfish were above the EU regulatory limit for a period of 35 weeks (Cusack et al. accepted for publication). A diarrhoeic shellfish poisoning (DSP) event in occurred in July and lasted $\sim$ 9 weeks, while an azaspiracid shellfish poisoning (AZP) event in October lasted $\sim$ 11 weeks. Biotoxin levels in the Bays blue mussels increased quickly when the causative

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organisms, Dinophysis (DSP biotoxins) and Azadinium-like species (AZP biotoxins), increased in the Bay. Figure 5 shows that both events were linked to downwelling when offshore surface water masses entered the bay. Another economic threat to the Irish shellfish industry is a biotoxin called domoic acid (DA). It can cause a serious human illness called amnesic shellfish poisoning that can induce, in extreme cases, symptoms of memory loss and even death. The rate that DA is excreted from shellfish is species specific. For example, the blue mussel (Mytilus edulis) quickly clears DA (Novaczek et al. 1991, 1992 Wohlgeschaffen et al. 1992). This is evident in the rapid increase and decline of a small Pseudo-nitzschia bloom and associated DA in long-line mussel cultures after an upwelling event occurred in Bantry Bay in April 2013 (Figure 5)."

P1196, L6: ' The model-derived products are not used in isolation, instead they are used as..' This is awkward phrasing. Why not : 'are integrated and used...'

Authors' changes in manuscript: As suggested the sentence is now revised to make it easier to read. "The model-derived products are integrated and used as part of a "tool kit" to estimate the risk to inshore shellfish farms."

P1196, L27: provide references to some examples.

Authors' changes in manuscript: References have been included: "The literature has a number of examples of attempts to classify sites, usually based on a combination of exposure (e.g. wave, wind, currents), accessibility (which is related to exposure), and distance to shore/infrastructure (e.g. Ágústsson, 2004; Perez et al., 2003; Ryan, 2004)."

P1201, L17-: This is actually a good way to finish this paper. As such I suggest making this paragraph the last one.

Authors' changes in manuscript: This section of the text has been removed from Paragraph #1 and made the last paragraph of the paper, as suggested. It reads: "Presented

products and services are relatively easily transferable to other geographical locations. Some will require a programming effort, e.g. coupling the shellfish ecophysiological and microbial contamination model to the ocean circulation and biogeochemical model of choice, whereas other will only need post-processing of standard ocean circulation models output and dissemination to stakeholders via user friendly data servers, such as ERDDAP. "

P1201, L22-: I suggest making this paragraph more objective and make it paragraph #1 of this section.

Authors' changes in manuscript: This paragraph is now Paragraph #1 of the Conclusions section. The text remains unchanged, since the authors are not sure about the exact nature of this query.

The authors would like to thank the Reviewer for a thorough review of the manuscript and useful comments.

Interactive comment on Ocean Sci. Discuss., 12, 1187, 2015.

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